Small Business Innovation Research/Small Business Tech Transfer

Monolithically Integrated TCC VCSELs with Surface-Normal 2D Slow-Light PC Waveguide Arrays, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

In this proposal, Dr. Dalir from Omega Optics Inc. (OO), in collaboration with University of Texas (UT) at Austin and the George Washington University propose a novel 2D TCC-VCSEL arrays monolithically integrated with a surface-normal slow-light photonic crystal (PC) waveguide array that are vertically built in one lithography layer. Unlike conventional thinking where the waveguides in a photonic integrated circuit (PIC) are always built parallel to the substrate, which will require 64 lithographically defined waveguide layers to provide a 64×64 phase array. Due to the slow light effect, this system provides the required phase shift larger than liquid crystal with 30 μm interaction length while maintaining the pixel (emitter) to pixel separation small enough to cover the total field of view (FOV) of 180°× 180°, and the instantaneous field of view of 0.05°.This will significantly increase the yield rate to the final targeted 98% since we have only one primarily defined lithography layer rather than a 64-layer approach without sacrificing the performance metrics. The steering of the laser beam can be realized through two different means: (1) electro-optically controlled through carrier perturbation or refilling the hole with EO polymer and (2) through thermal tuning which provides the needed phase shift of each element with the sweeping speed of >100 KHz. The key claims are the following:
1. Engineering the PC waveguide slow light device where the group index perturbation Δng can be significantly increased to 170-200, which will provide a much shorter waveguide length needed to steer the beam.
2. The unequally spaced design is capable of providing the side-lobe suppression up to 35 and 50 dB, respectively as required in phase I and phase II. This achievement is due to the design of non-overlapping sidelobes and the unequally coupled optical intensity of each element created by each subarray while maintaining a single steerable peak with the required IFOV and TFOV.

Anticipated Benefits

Our proposed device is useful for one main NASA application:

- It also can be used for novel space LIDAR technologies that use small and high-efficiency diode lasers to measure range and surface reflectance of asteroids and comets from >100 km altitude during mapping to <1 m during landing and sample return with a size, weight, and power substantially less than 28×28×26 cm^3, 0.1 kg, and 10 Watts out-put with one integrated device or 1 KWatts for arrays of 100 proposed devices.

Our proposed device is particularly useful in many Non-NASA applications requiring ultra-sensitive and standalone, including:

- Laser Marking,

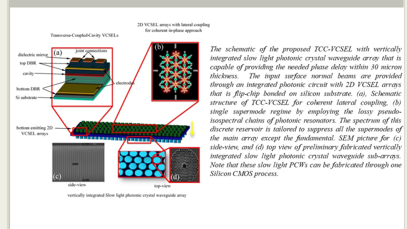

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Table of Contents

- Cutting and Welding,

- Materials Processing,

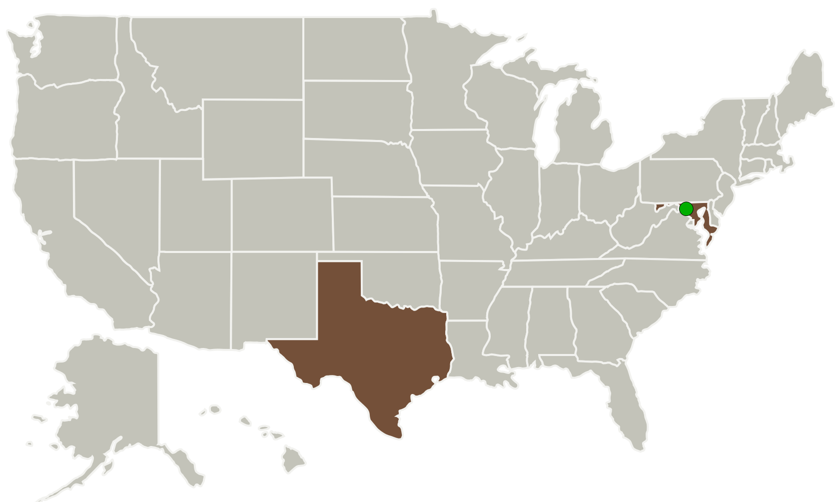
- High Power Spectroscopy,

- Non-Linear Optics,

- Laser Surgery (including cosmetic surgery, eye surgery, tattoo removal, kidney stones),

- LIDAR

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Omega Optics, Inc.	Lead Organization	Industry	Austin, Texas
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Omega Optics, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

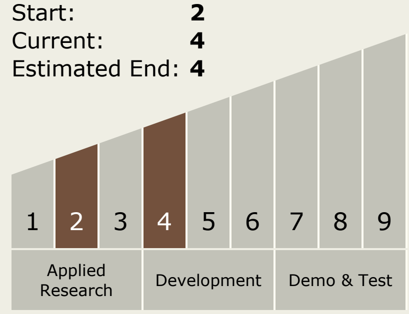
Carlos Torrez

Principal Investigator:

Hamed Dalir

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Primary U.S. Work Locations	
Maryland	Texas

Project Transitions

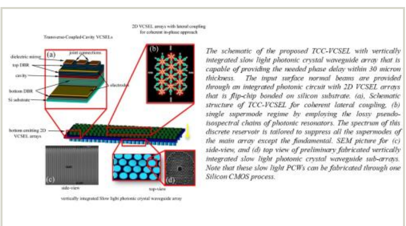
July 2018: Project Start

February 2019: Closed out

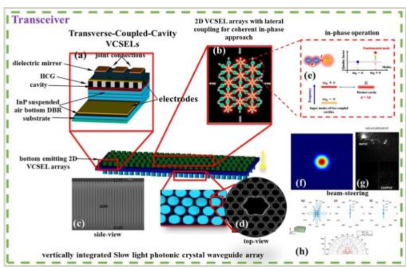
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141180)*

Images



Briefing Chart Image
Monolithically Integrated TCC VCSELs with Surface-Normal 2D Slow-Light PC Waveguide Arrays, Phase I
(https://techport.nasa.gov/image/131755)



Final Summary Chart Image
Monolithically Integrated TCC VCSELs with Surface-Normal 2D Slow-Light PC Waveguide Arrays, Phase I
(https://techport.nasa.gov/image/130762)

Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.1 Remote Sensing Instruments/Sensors
    └ TX08.1.5 Lasers

Target Destinations

Earth, Others Inside the Solar System